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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) High-Power Radiator

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(57) 6 Claims

Notice: The specification contained herein as filed

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TITLE OF THE INVENTION

High-power radiator

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a high-power radiator, in particular for ultraviolet light, having a discharge space which is filled with a filling gas emitting radiation under discharge conditions and whose walls are formed by a first and a second dielectric provided with metallic latticed or reticular first and second electrodes on its surfaces remote from the discharge space, and having an alternating-current source connected to the first and second electrodes for supplying the discharge.

In this connection, the invention proceeds from the prior art which emerges, for instance, from EP-A 0 254 111.

Discussion of Background

The industrial use of photochemical processes is heavily dependent on the availability of suitable UV sources. The conventional UV radiators provide low to medium UV intensities at a few discrete wavelengths such as, for example, the low-pressure mercury lamps at 185 nm and, in particular at 254 nm. Really high UV powers are obtained only from high-pressure lamps (Xe, Hg) but these then distribute their radiation over a larger wavelength range. The new excimer lasers have made a few new wavelengths available for fundamental photochemical experiments and are at present suitable for an industrial process probably only in exceptional cases for cost reasons.

The EP patent application mentioned in the introduction or, alternatively, the conference reprint entitled "Neue UV- und VUV- Excimerstrahler" ("New UV and VUV excimer radiators") by U. Kogelschatz and B. Eliasson

distributed at the Tenth Seminar of the Society of German Chemists, Specialist Group on Photochemistry, in Würzburg (FRG) on 18-20 November 1987, describe a new excimer radiator. This new type of radiator is based on the principle that excimer radiation can also be generated in dark electrical discharges, a type of discharge which is used on a large industrial scale in the generation of ozone. In the current filaments of this discharge, which are only present for a short time (< 1 microsecond), electron impact excites noble-gas atoms, which react further to form excited molecular complexes (excimers). Said excimers live only for a few hundred nanoseconds and give off their bonding energy in the form of UV radiation when they decompose.

The construction of such an excimer radiator largely corresponds to that of a conventional ozone generator including the power supply, with the essential difference that at least one of the electrodes and/or dielectric layers bounding the discharge space is transparent to the radiation generated. In addition to the high UV transmission, said electrodes must also have, inter alia, the following properties: good electric current conductivity, low cost, good flexibility in order to produce as intimate as possible a contact with the dielectric, and long service life. The long service life requires, in particular, a low chemical reactivity with the environment of the radiator. If it is desired to use the radiator as a light source in chemical reactors, even chemical inertness towards some substances is absolutely necessary for many applications.

SUMMARY OF THE INVENTION

Proceeding from the prior art, the object of the invention is to provide a high-power radiator, in particular for UV or VUV radiation, whose electrodes are ideally protected against environmental effects in addition to high UV transmission.

To achieve this object, provision is made, according to the invention, that at least the first electrodes are provided with a protective layer or embedded in such a layer.

A radiator having such a structure fulfills all the practical requirements:

- The electrodes exposed to the environment are protected against chemical attacks (prolonging of the service life);
- The electrodes are also protected, in addition, against physical attacks: discharges cause erosion; erosion removes electrode material which deposits on the transparent areas of the dielectric and reduces the transparency at those points;
- If the environment itself is a gas or liquid to be treated with UV radiation, a metallic contact with this substance is avoided in order not to initiate any additional chemical reactions in which metals are involved (chemical inertness);
- Any discharges (for example, Korona) in the environment of the electrodes onto the dielectric or to voltage-carrying parts situated in the vicinity, or surface discharges over the dielectric are avoided by better contact with the dielectric; the better electrical insulation of the electrodes prevents, in addition, undesirable energy-consuming discharges.

The invention can be implemented practically in various ways. In addition to the mere coating of the metallic wires, for example, by immersing the electrodes in a suitable bath, the immersion of the completely assembled radiator in a bath is advantageously possible. Coatings with so-called thick-film casting compounds which result in the advantage of an easy-to-clean outer surface of the radiator are also possible.

Suitable as coating or embedding material are, in particular, dielectric substances which make a good contact to the dielectric of the radiator and are at the same time easy to apply. If materials are also used in

this process which are UV-curing, they can be extremely rapidly cured by the radiator itself.

Particular developments of the invention and the further advantages achieved therewith are explained in greater detail below by reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein embodiments of high-power radiators are shown in extremely simplified form; in the drawing

Figure 1 shows a cylindrical UV radiator of known construction;

Figure 2 shows a portion of the outer dielectric tube of a UV radiator with outer electrode which is disposed thereon and composed of round wire coated with dielectric material;

Figure 3 shows a portion of the outer dielectric tube of a UV radiator with outer electrode which is disposed thereon and composed of round wire, the entire outer surface being provided with a coating material;

Figure 4 shows a portion of the outer dielectric tube of a UV radiator with outer electrode which is disposed thereon and composed of round wire situated in the depressions in the outer dielectric tube which are filled in their turn with coating material;

Figure 5 shows a portion of the outer dielectric tube of a UV radiator with outer electrode which is disposed thereon and is composed of round wire, with a smooth outer dielectric tube and a thick-film casting compound in which the electrodes are embedded;

Figure 6 shows a portion of a UV radiator which emits radiation both outwards and inwards.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, the UV high-power radiator shown diagrammatically in Figure 1 comprises an outer dielectric tube 1, for example made of quartz glass, and an inner dielectric tube 2 which is disposed concentrically therewith and whose inner wall is provided with an inner electrode 3. The annular space between the two tubes 1 and 2 forms the discharge space 4 of the radiator. The inner tube 2 is inserted in a gastight manner into the outer tube 1, which has previously been filled with a gas or gas mixture which emits UV or VUV radiation under the influence of dark electric discharges.

The outer electrode 5 used is a metal net or metal lattice which extends over the entire circumference of the outer tube 1. Both the outer electrode 5 and the outer dielectric tube 1 are transparent to the UV radiation generated.

The electrodes 3 and 5 are routed to the two poles of an alternating-current source 6. The alternating-current source basically corresponds to those such as are used to feed ozone generators. Typically it delivers an adjustable alternating voltage in the order or magnitude of several 100 volts to 20,000 volts at frequencies in the range of industrial alternating current up to and including a few 1000 kHz, depending on the electrode geometry, pressure in the discharge space 4 and composition of the filling gas.

The filling gas is, for example, mercury, noble gas, noble gas/metal vapor mixture, noble gas/halogen mixture, optionally with the use of an additional further noble gas, preferably Ar, He, Ne, as buffer gas.

Depending on the desired spectral composition of the radiation, a substance/substance mixture in accordance with the table below may be used in this connection:

Filling gas	Radiation
Helium	60 - 100 nm
Neon	80 - 90 nm
Argon	107 - 165 nm
Argon + fluorine	180 - 200 nm
Argon + chlorine	165 - 190 nm
Argon + krypton + chlorine	165 - 190, 200-240 nm
Xenon	160 - 190 nm
Nitrogen	337 - 415 nm
Krypton	124, 140 - 160 nm
Krypton + fluorine	240 - 255 nm
Krypton + chlorine	200 - 240 nm
Mercury	185, 254, 320-370, 390-420 nm
Selenium	196, 204, 206 nm
Deuterium	150 - 250 nm
Xenon + fluorine	340 - 360 nm, 400-550 nm
Xenon + chlorine	300 - 320 nm

In addition, a whole of number of further filling gases are possible:

- a noble gas (Ar, He, Kr, Ne, Xe) or Hg with a gas or vapor composed of F_2, I_2, Br_2, Cl_2 or a compound which releases one or more F, I, Br or Cl atoms in the discharge;
- a noble gas (Ar, He, Kr, Ne, Xe) or Hg with O_2 or a compound which releases one or more O atoms in the discharge;
- a noble gas (Ar, He, Kr, Ne, Xe) with Hg.

In the dark electric discharge (silent discharge) which forms, the electron energy distribution can be ideally adjusted by the thickness of the dielectrics and their properties and the pressure and/or temperature in the discharge space.

When an alternating voltage is applied between the electrodes 3, 5, a multiplicity of discharge channels

casting compound 8c on a smooth outer dielectric tube 1. The modern development of UV-curing products has made it possible to produce such casting compounds from clear enamel and even pigmented systems. Examples of UV-curing epoxy resins and UV-curing acrylates are described, for example, in the lecture manuscript of the Panacol-Elosol GmbH company entitled "UV-EPOXIES - Neue Möglichkeiten mit strahlungshärtenden Klebstoffen und Vergussmassen" ("UV-EXPOXIES - New possibilities using radiation-curing adhesives and casting compounds"), Haus der Technik e.V., Essen dated 20.11.1990. In such an arrangement, the "base" of the casting compound 8c, the outer dielectric tube 1, can be of thinner construction and in the limit case can even be omitted if the dielectric properties of the casting compound are matched to the discharge process.

The rearrangement, according to the invention, of the electrodes can be used successfully not only in cylindrical radiators but also in two-dimensional radiators. The outer electrodes themselves may also be of different design, for example not reticular or latticed, but consisting only of parallel strips, and this suggests itself, in particular, in an arrangement as shown in Figure 3.

Instead of separate or discrete electrode arrangements, those which are deposited by strip-type or lattice/reticular metallizations on the outer surface of the dielectric tube 1 and are then provided with a coating using the process described in connection with Figure 3 can also be used.

The invention was explained above by reference to exemplary embodiments which relate to so-called outward radiators. The measures of protecting the electrodes disclosed in this connection also apply, of course, to a so-called inward radiator. Apart from the position of the transparent electrodes 5, such an inward radiator corresponds to the outward radiator shown in Figure 1.

Furthermore, radiator configurations are also possible in which the UV radiation is radiated both outwards and inwards. Figure 6 illustrates a portion of such a radiator. In such arrangements, both dielectric tubes 1, 2 and also the respective electrodes 3, 5 have to be transparent to the radiation generated. In this case, both the first electrodes 5 and the second electrodes 3 can be ideally protected against chemical and physical attacks in the way described above.

Outward and inward radiators are normally cooled with a liquid coolant. In outward radiators, this is passed through the inner dielectric tube 2 and in inward radiators the coolant flows round the outer dielectric tube 1. Here, again, protective layers composed of the materials described contribute to preventing the erosive attack by the coolant or at least to reducing it. Insofar as electrodes are involved in this connection which must not transmit any UV radiation, other protective layers may also be used, for example those applied by anodizing, enameling etc. In the case of aluminum electrodes vapor-deposited or sputtered onto the dielectric, anodization of the free surface suggests itself. In the case of reticular or latticed electrodes which must not transmit any UV radiation, care must be taken that no (external) discharges occur between electrode and dielectric surface, which may take place as a result of filling the gap with an enamel or other fillers such as adhesive or nonconducting or conducting pastes, for example fluid silver.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:-

1. A high-power radiator, in particular for ultraviolet light, having a discharge space (4) which is filled with a filling gas emitting radiation under discharge conditions and whose walls are formed by a first and a second dielectric (1, 2) provided with a metallic latticed or reticular first (5) and second electrode (3) on its surfaces remote from the discharge space (4), and having an alternating-current source (6) connected to the first and second electrode for supplying the discharge, wherein at least the first electrodes (5) are provided with a protective layer (8; 8a; 8b; 8c) or are embedded in such a layer.

2. The high-power radiator as claimed in claim 1, wherein only the material of which the electrode (5, 3) is made is provided with a protective layer (8), preferably of wire enamel (Figure 2).

3. The high-power radiator as claimed in claim 1, wherein at least the first electrode (5) and at least the surface of the first dielectric (1) in the region of this electrode are provided with a UV-transparent protective layer (8a) (Figure 3).

4. The high-power radiator as claimed in claim 1 or 2, wherein the outer surface of the first dielectric (1) and/or the inner surface of the second dielectric (2) are/is provided with regular depressions in which the electrodes (5, 3) are at least partially embedded and the depressions are filled with a UV-transparent compound (8b) which covers the electrodes (5, 3) completely.

5. The high-power radiator as claimed in claim 1 or 3, wherein at least the first electrode (5) is embedded in a protective layer (8c) composed of a UV-transparent casting compound.

6. The high-power radiator as claimed in one of claims 1 to 5, wherein the protective layer is a UV-curing enamel, adhesive or casting compound which is cured by the radiator itself.

ABSTRACT OF THE DISCLOSURE

In order to protect, in the case of UV-high power radiators, the electrodes (5, 3) facing the process and/or coolant from environmental effects, they are coated with a protective layer (8a).

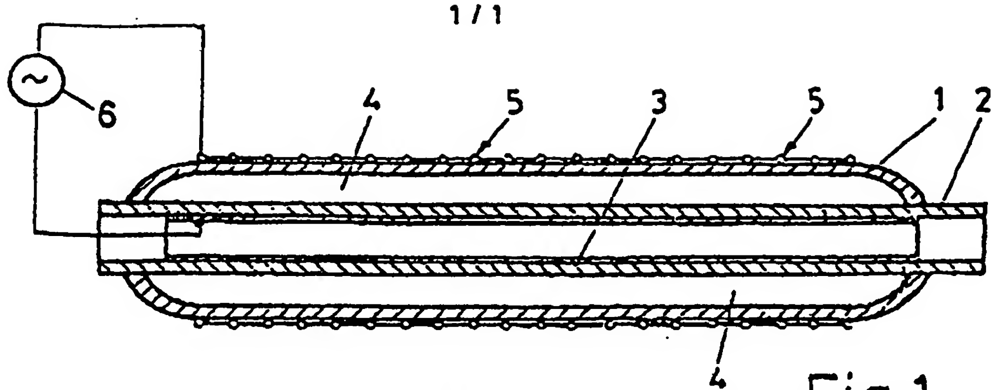

Fig.1

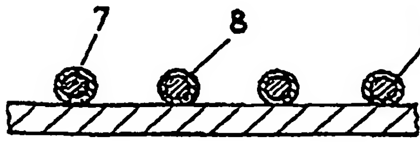

Fig.2

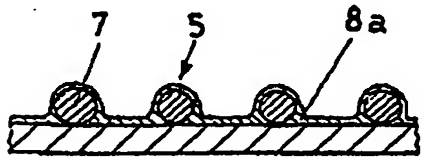

Fig.3

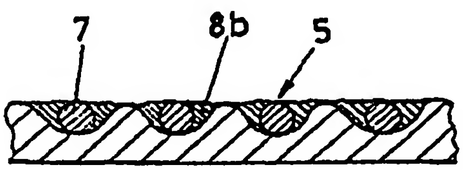

Fig.4

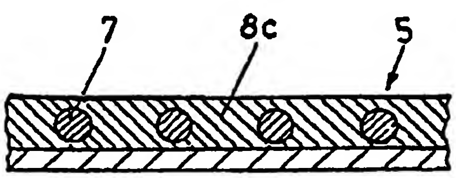

Fig.5

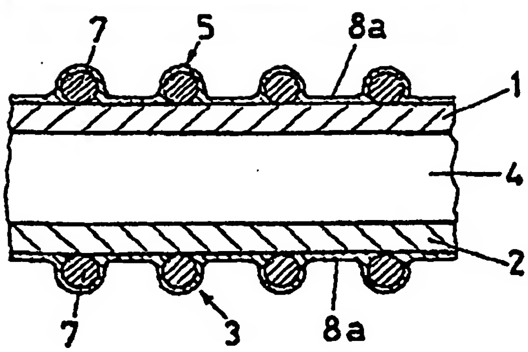

Fig.6

PATENT AGENTS

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